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JP 040143455 A

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(54) Abstract Title
Fuel injector having a restricted fuel flow path provided by a needle valve

(57) A fuel injector comprises a valve needle 16 slidable within a bore 12 formed in a nozzle body 10 and defines with the bore 12 a supply chamber 12 and delivery chamber 13. The needle has a thrust surface which is exposed to the delivery chamber 13 and the needle 16, at least in part, also defines restricted flow passages 60 which supply fuel to the delivery chamber 13. The needle 16 may have additional paths 63 which are blocked when the needle 16 is in a closed position against seat 14 and unblocked when the needle 16 is raised to an open position to allow increased flow of fuel. Also disclosed is a needle valve 16 which provides first and second guide regions 110a, 110c and a reduced diameter region 110b located between the first and second regions 110a, 110c. The reduced diameter region 110b and the bore define an annular chamber 118. A supply pipe 124 enters in to the annular chamber 118 and may have a section of reduced diameter 126 at the entry region which may be shaped, at 128, to reduce stress concentrations.

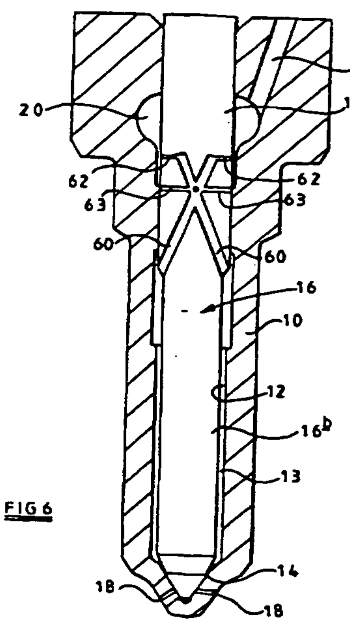

FIG 6

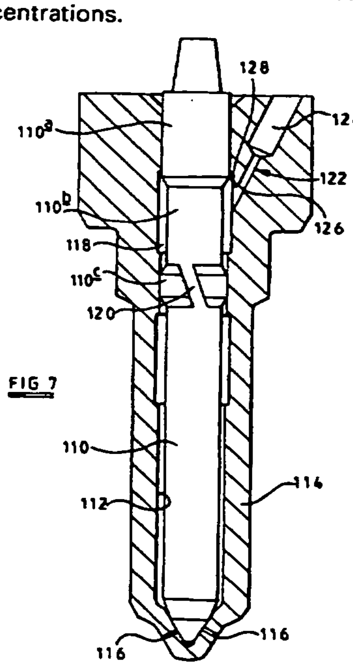

FIG 7

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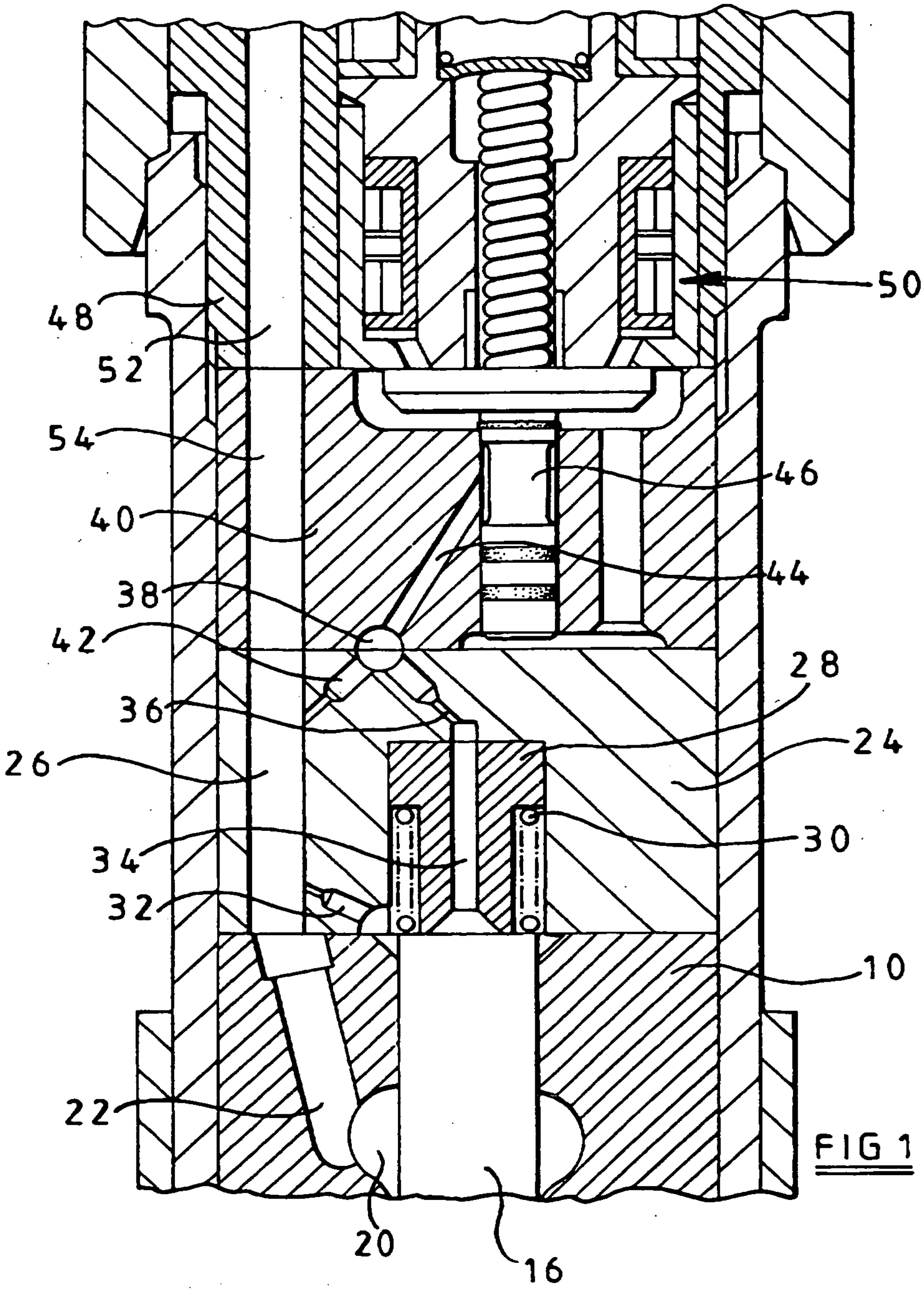


FIG 1

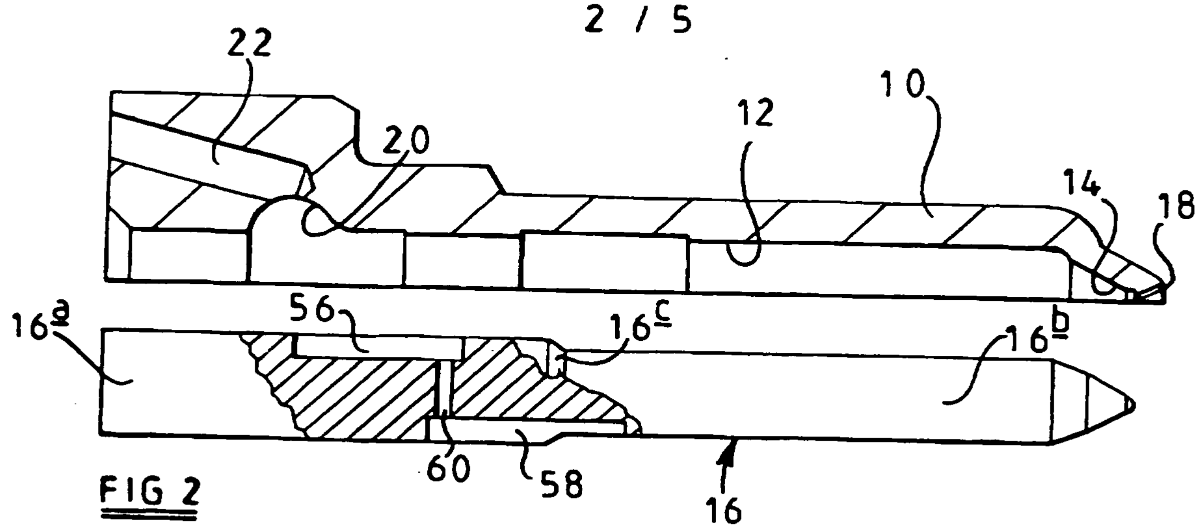


FIG 2

FIG 3

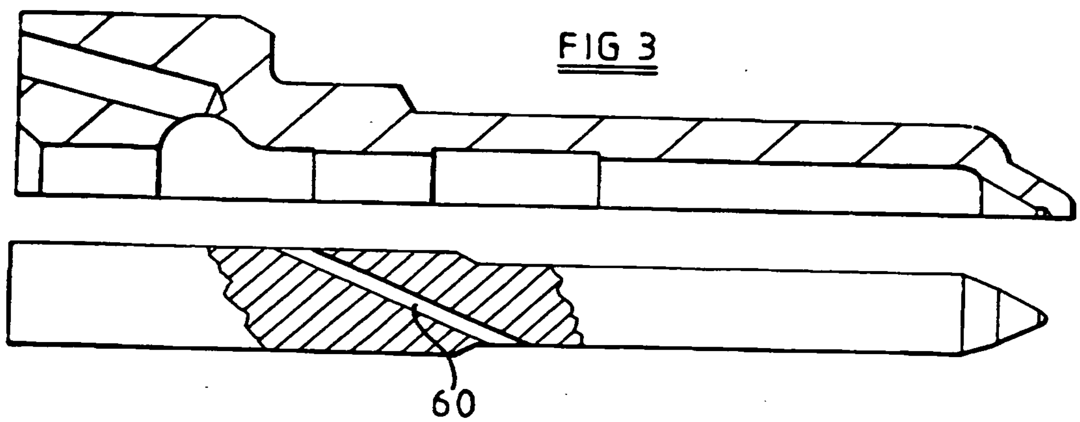
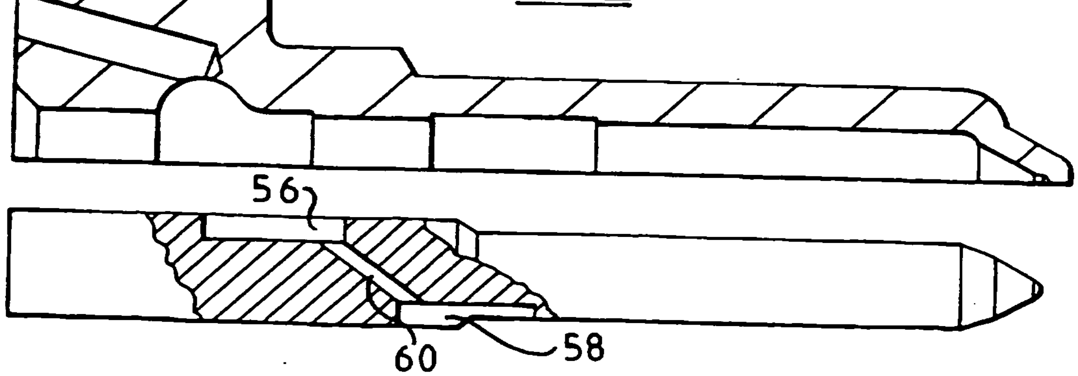


FIG 4



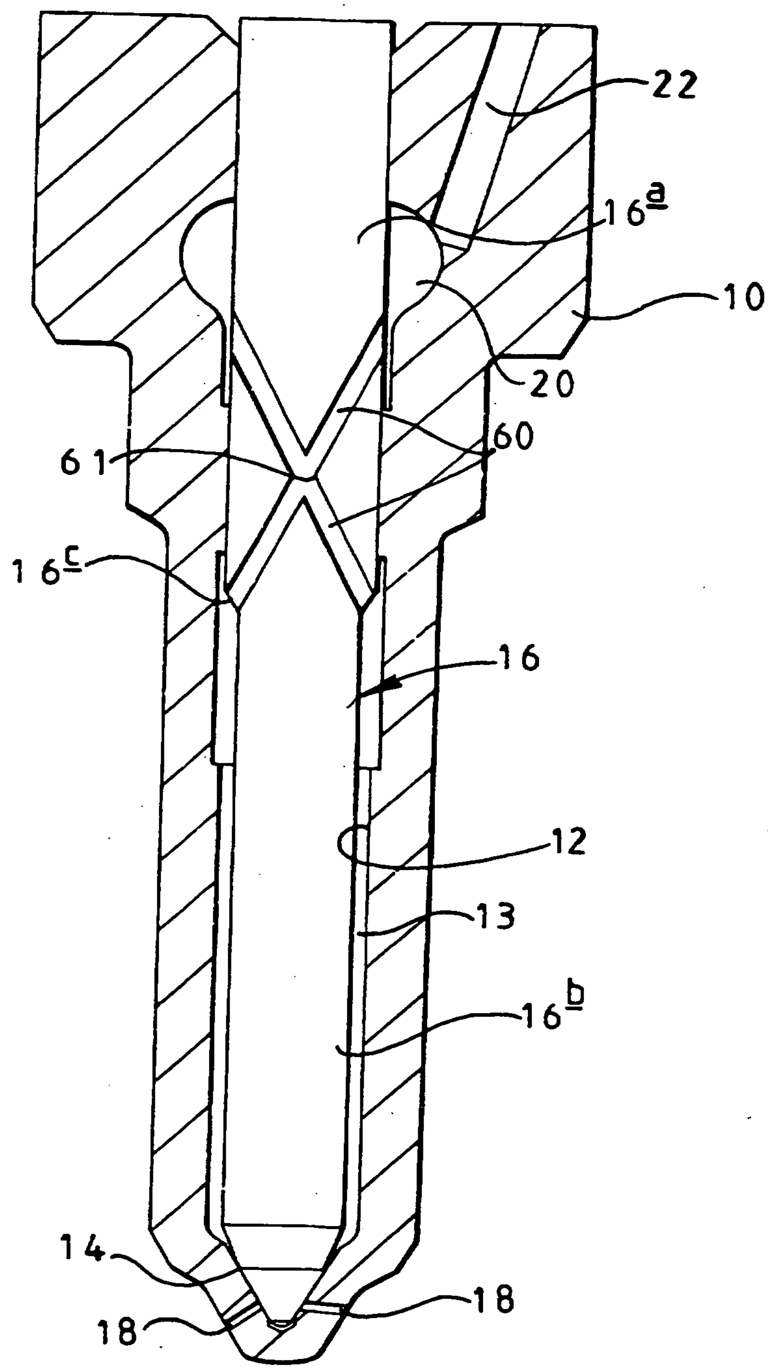


FIG 5

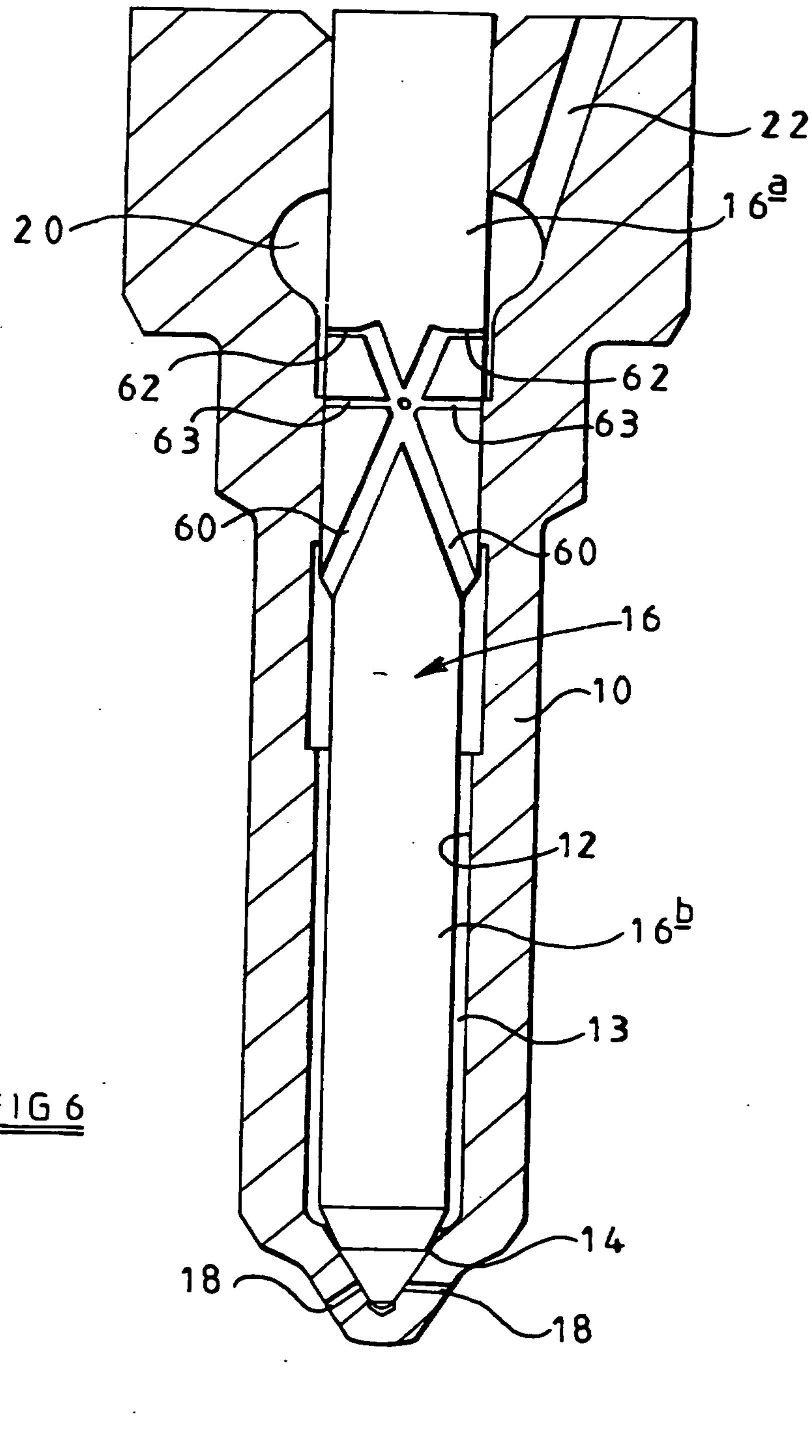


FIG 6

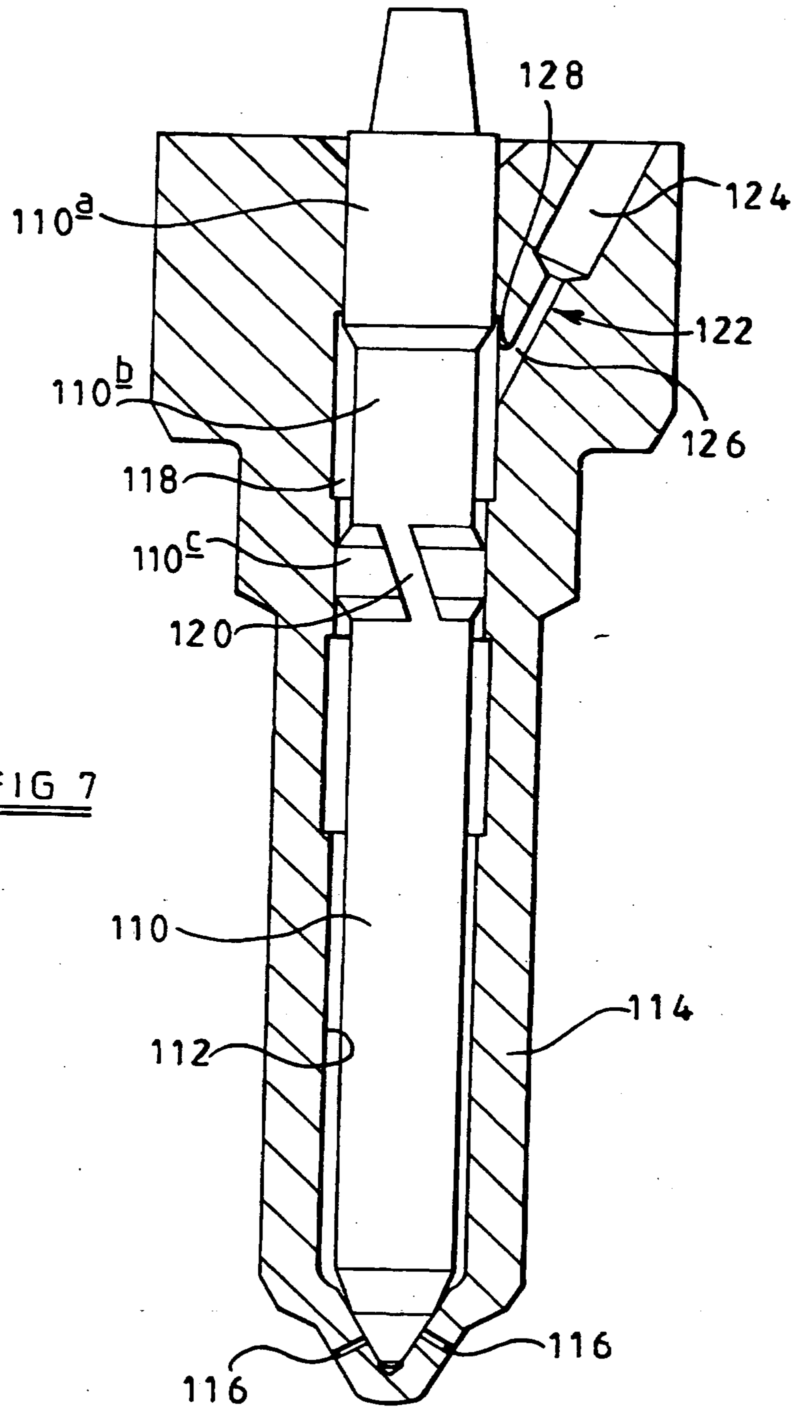


FIG 7

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FUEL INJECTOR

This invention relates to a fuel injector suitable for use in delivering fuel to a cylinder of a compression ignition internal combustion engine. In particular the invention relates to a fuel injector for use in a common rail type fuel system.

EP-A-0767304 describes a fuel injector for use in a common rail type fuel system, the injector including a restriction in the supply passage from the common rail towards the bore within which the valve needle is located. The provision of such a restriction results in the fuel pressure urging the needle away from its seating falling during injection thus permitting a rapid termination of injection. As the restriction is formed in the supply passage the manufacture of the part of the injector containing the restriction is relatively complex, and the injector cannot be manufactured using standard parts.

According to the present invention there is provided a fuel injector comprising a valve needle slidable within a bore provided in a nozzle body and engageable with a seating to control the delivery of fuel from the bore, the needle and nozzle body together defining a delivery chamber, the needle being provided with a thrust surface exposed to the fuel pressure within the delivery chamber, wherein the delivery chamber is supplied with fuel from a supply chamber through a restricted flow path defined, at least in part, by the needle.

By providing the restriction in the form of a restricted flow path provided in the needle, or defined, at least in part, by the needle, the number of

non-standard parts used in the injector can be reduced, the needle conveniently taking the form of a standard part which has been modified to incorporate the restricted flow path.

The valve needle may be provided with a plurality of flow passages, each flow passage permitting fuel to flow from the supply chamber to the delivery chamber, the flow passages intersecting one another to define a flow restriction, the flow passages and flow restriction together forming the restricted flow path.

It will be appreciated that at the restriction defined by the intersection of the flow passages, the effective area through which fuel can flow is smaller than that defined by the parts of the flow passages upstream and downstream of the restriction. As the flow restriction is defined by the intersection of a plurality of passages, each of which may take the form of a drilling of uniform diameter throughout its length, the flow restriction can be formed relatively easily.

The flow passages are conveniently equi-angularly spaced around the valve needle in order to reduce or avoid the application of side loadings to the needle.

The injector may be provided with an additional flow path permitting fuel flow between the supply and delivery chambers at an increased rate, the additional flow path being closed when the valve needle engages its seating, and opening upon movement of the valve needle away from its seating beyond a predetermined position.

The restricted flow path and additional flow path are preferably formed in the valve needle, and are preferably arranged in a symmetrical, balanced, manner.

The invention also relates to a valve needle suitable for use in such an injector.

According to a second aspect of the invention there is provided a fuel injector of the inwardly opening type comprising a valve needle slidable within a bore formed in a nozzle body, the needle including first and second guide regions of diameter substantially equal to the diameter of the adjacent parts of the bore, and a region of reduced diameter located between the first and second guide regions and defining, with the bore, an annular chamber, the nozzle body being provided with a supply passage which communicates with the annular chamber.

Such an arrangement is advantageous in that the formation of an annular gallery can be avoided thus the manufacturing process can be simplified and the nozzle body can be of increased strength.

Conveniently, the supply passage includes a region of small diameter. The region of small diameter is preferably provided at the end of the supply passage which opens into the annular chamber. Such an arrangement is advantageous in that the nozzle body is of increased strength.

According to another aspect of the invention there is provided an injector comprising a needle slidable within a bore provided in a nozzle body, the

needle and bore together defining an annular chamber, the nozzle body being provided with a supply passage which communicates with the annular chamber, wherein the supply passage includes, at its end which opens into the annular chamber, a region of small diameter.

The invention will further be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a sectional view of part of a fuel injector in accordance with an embodiment of the invention;

Figure 2 illustrates the valve needle and part of the nozzle body of the embodiment of Figure 1;

Figures 3 and 4 are views similar to Figure 2 illustrating alternative embodiments;

Figures 5 and 6 illustrate the valve needles and nozzle bodies of two further embodiments; and

Figure 7 is a view similar to Figures 5 and 6 illustrating another embodiment.

The fuel injector illustrated in Figures 1 and 2 comprises a nozzle body 10 having a blind bore 12 formed therein, the blind bore 12 defining, adjacent its blind end, a seating 14 with which an end region of a valve needle 16 is engageable. The valve needle 16 is of stepped form and includes a region 16a of relatively large diameter, and a region 16b of

reduced diameter, an angled surface 16c interconnecting the regions 16a, 16b. The end region of the valve needle 16 which is arranged to engage the seating 14 is of frustoconical form, the end region and the region 16c defining thrust surfaces arranged such that the application of fuel under pressure to the bore 12 applies a force to the valve needle 16 urging the valve needle 16 away from the seating 14 to permit fuel to flow from the bore 12 past the seating 14 to one or more small openings 18 which communicate with the blind end of the bore 12.

The region 16a of the needle 16 is of substantially the same diameter as the bore and forms a substantially fluid tight seal therewith, the engagement of the region 16a of the needle 16 with the wall defining the bore 12 acting to guide the needle 16 for sliding movement relative to the nozzle body 10. The reduced diameter region 16b of the valve needle 16 forms, with the bore 12, a chamber, the thrust surfaces of the needle 16 being exposed to the fuel pressure within the chamber.

A part of the bore 12 adjacent part of the region 16a of the needle 16 is of enlarged diameter and defines an annular gallery 20 which communicates with a drilling 22 provided in the nozzle body 10.

As illustrated in Figure 1, the upper end of the nozzle body 10 abuts a spring housing 24 which is provided with a drilling 26 which communicates with the drilling 22. The spring housing 24 is provided with a blind bore which houses a needle stop member 28. A spring 30 being engaged between the needle stop member 28 and an upper end of the needle 16, the needle stop member 28 guiding the spring 30 and acting to limit movement of the valve needle 16 away from the seating 14.

The spring housing and needle stop member 28 together define a spring chamber which communicates through a restricted passage 32 with the drilling 26. Clearly, the upper end of the valve needle 16 is exposed to the fuel pressure within the spring chamber, the fuel pressure acting upon the upper end of the valve needle 16 assisting the spring 30 in urging the valve needle 16 towards the seating 14.

The needle stop member 28 defines a passage 34 which communicates with a restricted passage 36 provided in the spring housing 24, the restricted passage 36 communicating with a chamber 38 defined between an upper end surface of the spring housing 24 and a lower end surface of a valve housing 40 which abuts the spring housing 24. A further restricted passage 42 provides a restricted flow path between the drilling 26 and the chamber 38.

The valve housing 40 is provided with a passage 44 which communicates with the chamber 38, the passage 44 communicating with a bore housing a valve member 46 which is spring biased into engagement with a seating defined around an upper end of the bore, in the orientation illustrated in Figure 1. The engagement of the valve member 46 with its seating controls the flow of fuel from the spring chamber through the passages 36, 44 to a low pressure drain reservoir.

The upper end of the valve housing 40 engages the lower end surface of an actuator housing 48 which houses an electromagnetic actuator 50 arranged to control movement of the valve member 46. The valve housing 40 and actuator housing 48 are provided with drillings 52, 54 which communicate with one another and with the drilling 26 provided in

the spring housing 24. The drillings 52, 54, 26, 22 define a supply passage whereby fuel is supplied under high pressure from a common rail to the annular gallery 20.

As illustrated in Figure 2, the valve needle 16 is shaped to include a recess 56 which defines, with the bore 12, a first chamber, and a recess 58 which defines, with the bore 12, a second chamber. A drilling 60 of relatively small diameter provides a restricted flow path between the first and second chambers, thus providing a restricted flow path between the annular gallery 20 and the chamber defined between the region 16b of the valve needle 16 and the bore 12.

In use, when the actuator 50 is not energized, the valve member 46 engages its seating thus fuel is unable to escape from the spring chamber to the low pressure drain reservoir. The supply passage defined by the drillings 52, 54, 26, 22 is connected to the common rail and is supplied with fuel at high pressure. The fuel pressure within the chamber defined between the region 16b of the valve needle 16 and the bore 12 is therefore high. Similarly, the fuel pressure within the spring chamber is high. As the area of the valve needle 16 exposed to the fuel pressure within the spring chamber is greater than the effective areas of the thrust surfaces, the valve needle 16 is urged into engagement with its seating 14. The spring 30 assists in urging the valve needle 16 into engagement with its seating 14.

In order to commence injection, the actuator 50 is energized resulting in movement of the valve member 46 away from its seating. Such movement permits fuel to escape from the spring chamber through the

restricted passage 36 and passage 44. The rate at which fuel can escape from the spring chamber is greater than the rate at which fuel is supplied thereto through the restricted passage 32, thus the fuel pressure within the spring chamber falls. A very small quantity of fuel also escapes from the drilling 26 through the restricted passage 42 to the passage 44, but the restricted passage 42 is of dimensions to ensure that this flow of fuel is very small. The reduction in the fuel pressure within the spring chamber is sufficient to permit the valve needle 16 to move away from the seating 14 under the action of the fuel pressure upon the thrust surfaces. Such movement results in the commencement of fuel injection.

Movement of the valve needle 16 continues until the valve needle 16 moves into engagement with the needle stop member 28. Once such engagement occurs, it will be appreciated that fuel can no longer escape from the spring chamber, thus the continued flow of fuel through the restricted passage 32 results in the fuel pressure within the spring chamber increasing. It will be appreciated, however, that the area of the valve needle 16 exposed to the increased fuel pressure within the spring chamber at this time is relatively small, part of the end surface of the valve needle 16 being exposed to the fuel pressure within the passage 34 at this time.

As fuel injection occurs, the fuel pressure within the chamber defined between the region 16b of the valve needle 16 and the bore 12 reduces, the supply of fuel to this chamber being restricted as fuel is only permitted to flow through the passage 60 at a restricted rate. Clearly, therefore, the force acting upon the thrust surfaces of the valve needle is reduced.

When injection is to be terminated, the actuator 50 is de-energized and the valve member 46 returns into engagement with its seating. As a result, fuel is no longer able to escape from the passage 44 to the low pressure drain reservoir. Fuel flowing through the restricted passage 42 and restricted passage 36 increases the fuel pressure within the passage 34, thus the force urging the valve needle 16 towards its seating 14 is increased. Further, as at this stage in the operation of the injector the force urging the valve needle 16 away from its seating 14 is reduced due to the pressure acting upon the thrust surfaces having fallen to a relatively low level, movement of the valve needle 16 into engagement with its seating 14 occurs rapidly thus resulting in a rapid termination of injection. After injection has terminated, the fuel pressure within the chamber defined between the region 16b of the needle 16 and the bore 12 is able to return to substantially the same pressure as that within the supply passage.

It will be appreciated that a number of the components from which the injector is manufactured are standard, the invention residing in the modification of the injector needle to incorporate a restricted passage controlling the rate at which fuel is supplied to the chamber defined between the region 16b of the needle 16 and the bore 12.

The arrangement illustrated in Figure 4 is similar to that of Figure 2 but instead of the restricted passage 60 taking the form of a passage extending across the diameter of the valve needle 16, the passage 60 is orientated at an angle to the axis of the valve needle 16. As a result, the recesses 56, 58 defining the first and second chambers can be of reduced axial extent. Figure 3 illustrates a further modification in which the angled passage 60 communicates directly with the annular gallery 20 and the chamber

defined between the region 16b of the needle 16 and the bore 12, the recesses defining the first and second chambers 56, 58 being omitted.

In the arrangement illustrated in Figure 5, the valve needle 16 is provided with a pair of drillings 60, each of which defines a flow passage permitting fuel to flow from the annular gallery 20 to a delivery chamber 13. The drillings 60 intersect one another to define a flow restriction 61 restricting the rate at which fuel is able to flow from the gallery 20 to the delivery chamber 13. It will be appreciated that the effective area of the restriction 61 through which fuel is able to flow is smaller than the effective flow areas defined by the parts of the flow passages within the needle 16 upstream and downstream of the restriction 61.

In a typical arrangement, the drillings 60 are of diameter approximately 0.48 mm, the drillings extending at an angle of approximately 20° to the injector axis. In such an arrangement, the area of the intersection is equivalent to providing a restriction of diameter approximately 0.5 mm. In order to minimise stress in the needle, the drillings 60 should be as close to perpendicular to one another as possible. Further, in order to avoid bending of the needle, the drillings 60 should be arranged symmetrically.

In the embodiment described hereinbefore with reference to Figure 5, it will be appreciated that the area of the restriction 61 is dependent upon the diameters of the drillings 60 and the angle of intersection of the drillings 60, and these parameters can be selected according to the intended use of the injector.

As the drillings 60 are arranged equi-angularly and symmetrically, it will be appreciated that the application of side loadings to the needle 16 is avoided. In such an arrangement, the restriction 61 is of ellipsoidal cross-sectional shape. If desired, one or more additional drillings 60 may be provided, the shape and effective size of the restriction 61 changing accordingly. A further advantage of providing additional drillings is that bending of the needle, in use, is reduced thereby reducing the application of side loadings to the needle. It is advantageous to avoid applying side loads to the needle as the application of such side loads generate frictional forces between the needle and the wall of the bore which may result in inconsistent operation and impaired performance. In extreme cases, seizure of the needle within the bore may occur.

In the arrangement illustrated in Figure 6, the needle 16 is provided with a pair of drillings 60 which communicate with the delivery chamber 13. The drillings 60 are of blind form, and communicate, adjacent their blind ends, with radially extending restricted diameter drillings 62 which are located to communicate with the annular gallery 20 throughout the range of movement of the needle 16, in use. The needle 16 is further provided with four additional restricted passages 63 which communicate with the blind drillings 60 and which are located in such positions that, when the needle 16 engages its seating, the outer end of each of the additional passages 63 is closed by the adjacent part of the bore 12. Movement of the valve needle 16 away from its seating beyond a predetermined position results in the outer ends of the additional passages 63 being opened and in communication being permitted between the supply chamber and the additional passages 63.

In use, when the valve needle 16 occupies a position in which the conical end surface thereof engages the seating 14, it will be appreciated that delivery of fuel through the outlet apertures 18 does not occur. At the commencement of injection, movement of the needle 16 away from the seating 14 by a small distance results in fuel from the delivery chamber 13 being permitted to flow past the seating 14 to the outlet apertures 18. At this stage in the operation of the injector, fuel supply to the delivery chamber 13 occurs by way of the restricted drillings 62, thus as fuel is only supplied to the delivery chamber 13 at a restricted rate, the rate at which fuel is supplied through the outlet apertures 18 is restricted. However, as the restriction to the rate at which fuel is delivered is governed by the dimensions of the restricted drillings 62 and is not substantially influenced by the distance by which the needle 16 is lifted from the seating 14, it will be appreciated that the needle 16 can be arranged to be lifted from its seating 14 by a distance sufficient to ensure that the spray pattern is not interfered with, for example due to the seating 14 and end part of the needle 16 being slightly eccentric to one another.

When fuel is to be delivered at a higher rate, the needle 16 is lifted from the seating 14 by a further distance resulting in the additional passages 63 gradually coming into communication with the supply chamber, thus gradually increasing the area through which fuel can flow. As a result, the rate at which fuel can flow to the delivery chamber 13 is increased, the fuel flowing both through the restricted drillings 62 and the additional passages 63. As fuel is being supplied to the delivery chamber 13 at a higher rate, fuel delivery through the outlet apertures 18 at a higher rate as determined by the size of the apertures can be achieved.

The dimensions of the restricted drillings 62 are chosen to ensure that when the valve needle 16 is lifted from its seating by the first distance, at which fuel delivery is to be at the low rate, the restriction to fuel flow rate caused by the restricted passages 62 is greater than the restriction to flow resulting from the clearance between the end of the needle 16 and the seating 14 and the restriction formed by the apertures 18. It will be appreciated, therefore, that at this stage in the operation of the injector, the clearance between the valve needle 16 and seating 14 does not act to substantially throttle the rate at which fuel is delivered, such throttling being dominated by the restricted drillings 62.

The injector of which part is illustrated in Figure 6 may take the form of a common rail injector incorporating appropriate control valve means or an appropriate actuator, for example as shown in Figure 1, to cause movement of the valve needle 16 at the appropriate time through an appropriate distance. Alternatively, the valve needle 16 may be biased into engagement with the seating 14 by a spring, appropriate means being provided to permit movement of the valve needle 16 against the action of the spring at the appropriate time during the injection cycle.

Although as described hereinbefore, the restricted drillings 62 and additional passages 63 are provided in the valve needle 16, it will be appreciated that, if desired, one or more of these passages may be provided in the nozzle body 10 rather than the valve needle 16. Further, although the valve needle 16 is provided with a pair of drillings 60, a pair of restricted drillings 62 and four additional passages 63, it will be appreciated that other numbers of drillings and passages may be provided. For example fewer drillings and passages may be provided when it is

desired to simplify manufacture or improve fuel flow consistency, or more drillings and passages may be provided where it is desired to reduce the application of side loads to the needle and reduce bending. Further, the additional passages 63 may be arranged so that different numbers of the additional passages 63 become available for use in supplying fuel from the supply chamber to the delivery chamber 13 as the needle 16 is lifted from its seating 14.

Where the injector is intended to form part of a common rail type fuel injector, the provision of the restricted drillings 62 and additional passages 63 may be arranged to ensure that the fuel pressure within the delivery chamber 13 falls, during injection, thus permitting the valve needle 16 to return into engagement with its seating 14 rapidly and hence permitting accurate control of the termination of injection.

Figure 7 illustrates part of fuel injector of the inwardly opening type intended for use in delivering fuel under high pressure to a combustion space of an associated compression ignition internal combustion engine. The injector comprises a valve needle 110 which is slidable within a blind bore 112 formed in a nozzle body 114. The bore 112 is of stepped form, and defines adjacent the blind end thereof, a frusto-conical seating with which the needle 110 is engageable to control the supply of fuel from the bore 112 to a plurality of outlet openings 116 which communicate with the bore 112 downstream of the seating.

The needle 110 is shaped to include a first, upper guide region 110a which is of diameter substantially equal to the diameter of the adjacent part of the bore 112. Beneath the region 110a, the needle 110 includes a

region 110b of reduced diameter, and beneath this, the needle 110 includes a second guide region 110c of diameter substantially equal to the diameter of the adjacent part of the bore 112. It will be appreciated that the first and second relatively large diameter guide regions 110a, 110c are spaced from one another, and that the reduced diameter region 110b and the bore 112 together define an annular chamber 118. In use, fuel is able to flow from the annular chamber 118 through flutes 120 provided in the guide region 110c towards the seating.

A supply passage 122 communicates with the annular chamber 118. The supply passage 122 is defined by a relatively large diameter blind drilling 124 which is coaxial with a drilling 126 of reduced diameter, the reduced diameter drilling 126 being located so as to open into the annular chamber 118, thus providing a restricted flow path between the drilling 124 and the chamber 118. In order to reduce the formation of points of stress concentration in the area at which the reduced diameter drilling 126 opens into the annular chamber 118, a radius 128 is formed at the point at which the drilling 126 opens into the annular chamber 118.

In use, fuel under pressure is supplied to the supply passage 122 from, for example, a common rail or an alternative source of fuel under pressure. The application of fuel under high pressure to the bore 112 applies a force to the needle 110 urging the needle 110 out of engagement with the seating, and an appropriate control arrangement is provided to control whether or not movement of the needle 110 is permitted. The control arrangement may, for example, include an electromagnetically actuable valve which controls the fuel pressure applied to an upper end surface of

the needle 110, or alternatively, the actuator may take the form of a piezoelectric actuator arrangement.

When fuel injection is to take place, the actuator arrangement is energized in such a manner as to permit the needle 110 to move away from its seating, thus permitting fuel from the supply passage 124 to flow through the bore 112 and past the seating to the outlet openings 116. In order to terminate injection, the actuator arrangement is de-energized to return the needle 110 into engagement with the seating, thus terminating the flow of fuel to the outlet openings 116.

It will be appreciated that the arrangement illustrated in Figure 7 is advantageous in that the provision of an annular gallery in the bore 112 is avoided, thus the manufacturing process is simplified, and as the quantity of material removed from the nozzle body 114 during manufacture is reduced, the nozzle body is of improved strength. Additionally, as the cross-sectional area of the opening defined at the connection of the supply passage 122 to the annular chamber 118 is relatively small due to the location of the small diameter drilling 126, the strength of the nozzle body 114 is further improved.

It will be appreciated that the arrangement of Figure 7 is a particularly advantageous embodiment, but that the invention also applies to arrangements in which the diameter of the part of the supply passage 122 which opens into the annular chamber 118 is relatively large. The invention also applies to arrangements including an annular gallery, and in which the part of the supply passage which opens into the annular gallery is of small diameter.

CLAIMS

1. A fuel injector comprising a valve needle slidable within a bore provided in a nozzle body and engageable with a seating to control the delivery of fuel from the bore, the needle and nozzle body together defining a delivery chamber, the needle being provided with a thrust surface exposed to the fuel pressure within the delivery chamber, wherein the delivery chamber is supplied with fuel from a supply chamber through a restricted flow path defined, at least in part, by the needle.

2. An injector as claimed in Claim 1, wherein the restricted flow path comprises at least one drilling of small diameter provided in the needle.

3. An injector as claimed in Claim 1, wherein the needle is provided with a plurality of flow passages, each flow passage permitting fuel to flow from the supply chamber to the delivery chamber, the flow passages intersecting one another to define a flow restriction, the flow passages and flow restriction together forming the restricted flow path.

4. An injector as claimed in Claim 3, wherein the flow passages are equi-angularly spaced around the valve needle in order to reduce or avoid the application of side loadings to the needle.

5. An injector as claimed in Claim 1 or Claim 2, further comprising an additional flow path permitting fuel flow between the supply and delivery chambers at an increased rate, the additional flow path being closed when the valve needle engages its seating, and opening upon

movement of the valve needle away from its seating beyond a predetermined position.

6. An injector as claimed in Claim 5, wherein the additional flow path comprises at least one drilling provided in the needle.

7. A fuel injector of the inwardly opening type comprising a valve needle slidable within a bore formed in a nozzle body, the needle including first and second guide regions of diameter substantially equal to the diameter of the adjacent parts of the bore, and a region of reduced diameter located between the first and second guide regions and defining, with the bore, an annular chamber, the nozzle body being provided with a supply passage which communicates with the annular chamber.

8. A fuel injector comprising a needle slidable within a bore provided in a nozzle body, the needle and bore together defining an annular chamber, the nozzle body being provided with a supply passage which communicates with the annular chamber, wherein the supply passage includes, at its end which opens into the annular chamber, a region of small diameter.

9. A fuel injector substantially as hereinbefore described with reference to any one of the accompanying drawings.

10. A valve needle adapted for use in a fuel injector as claimed in any one of Claims 1 to 7 and 9.

The Patent Office

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INVESTOR IN PEOPLE

Application No: GB 9901849.1
Claims searched: 1-6
Examiner: David Glover
Date of search: 22 April 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F1B (B2JCB)

Int Cl (Ed.6): F02M 61/10, 61/12

Other: Online: EPODOC, PAJ, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2147950 A	(Lucas) see figure showing injector needle with supply passage 18 and thrust surfaces exposed to chamber 20	1, 2
X	GB 2118624 A	(British internal combustion engine research institute) see figure 1 note passage 18 and needle 20 with thrust surfaces exposed to chamber 19	1, 2
A	GB 2112455 A	(Lucas)	
X	JP 040143455	(Nissan) see figure and note annular chamber 12, delivery chamber 18 and flow path 19	1-4

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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E Patent document published on or after, but with priority date earlier than, the filing date of this application.